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# HIGH-TECH INDUSTRIES AND THE STRUCTURE OF FOREIGN TRADE
## A STUDY BY MICHIAKI KAWANO OF THE BANK OF TOKYO*

Summary

Japan finally pulled within bumping room of West Germany as the non-communist world's second-biggest exporter in 1984 and, in the process, gained ground on the United States. The key to this development, the Bank of Tokyo's Michiaki Kawano argues in the following article, is the more rapid adaptation of Japan's industrial structure to the changing realities of international competition. High-technology sectors, particularly in the electronics and precision instrumentation fields, are increasingly displacing old-line industries like steel and textiles as the engine of Japanese industrial expansion. While the continuation of this process is pivotal to the future health of the Japanese economy, it could put Japan on a more frequent collision course with the United States and other industrialized nations.

## Introduction

Japan's trade and current accounts have shown consistent surpluses since the emergence of a global economic recovery in 1983. The trade surplus reached $31.5 billion in 1983 and $41.4 billion in 1984. The current account surplus amounted to $20.8 billion in 1983, rising to $35 billion in 1984.

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A number of external factors have been involved in the development of these massive surpluses. Prominent among them are the rapid growth of the American economy, the trend toward a strong dollar and a weak yen, and the decline in oil prices. Internal factors have also been involved, notably the vigorous growth of high-tech industries in Japan, a development with important structural implications. High-tech industries tend to be based on production technology systems introduced subsequent to the oil crises. By specializing in high-tech fields, Japan is in the process of building an extremely efficient economic structure.

Below we will examine the expansion of high-tech industries in Japan. After clarifying the resultant changes that are occurring in the structure of Japan's foreign trade, we will discuss some implications and problems.

## What Are High-Tech Industries?

### 1. Contemporary High-Tech Industries

The term high-tech industry is generally used to refer to any industry that is based primarily on sophisticated technology. Unlike industries of earlier eras similarly dependent on the vanguard technologies of the time, contemporary high-tech industries are expected to become mainstays of the economy during the 1980s and the 1990s. Not long ago advanced technology was associated with so-called big science, or science and technology used in major government and military projects in such fields as aeronautics, space, nuclear power, and nuclear fusion research. Science and technology in these fields entail huge investments of money, human resources, and facilities. In part because applications are limited, developments in these fields have had little relevance to civilian industries.

In contemporary high-tech industries, however, the results of development programs are finding immediate application in the civilian sector. The range of applications is extremely broad, and new developments are profoundly affecting daily life.

Typical of these high-tech fields is the electronics industry. The appearance of sophisticated, miniaturized electronics devices at increasingly low prices has created a growing range of applications in various industries, such as machinery, medicine, telecommunications, and data processing. Each new demand category stimulates further expansion in the size of the market.

What specific industries are currently included in the high-tech category? Existing high-tech industries, including those still in their infancy, might be cataloged as follows:

a. Electronics (telecommunications, office and factory automation, electromechanics, medical electronics, optoelectronics)

b. New materials (amorphous materials, new ceramics, functional macromolecules, single crystals, fibers, new alloys)

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c. Biotechnology (pharmaceuticals, agrichemicals, fertilizers, foods, biomass)

Industries in the electronics category have already taken off and are now in a high-growth phase. The new materials industries are about to take off, and biotechnology is expected to get off the ground during the late 1990s. Most existing successful high-tech industries, accordingly, are in the electronics field. These industries include electric machinery and other industries producing machinery and equipment.

2. Characteristics of High-Tech Industries

A study of the characteristics of high-tech industries reveals first that these industries tend to be based on production technology systems that emerged after the oil crises. They have all achieved substantial improvements in energy and resource consumption and productivity, and they have also developed the potential to manufacture wide varieties of products in small quantities.

Second, the pace of innovation in these industries is extremely rapid, with the result that they face an extremely heavy burden of capital investment and research and development costs. This feature has necessitated innovative changes in the area of business management.

Third, the border between civilian and military applications is blurred. Modern military applications demand sophisticated telecommunications and control systems. The electronics hardware used in military equipment is almost identical in technical level to the hardware used in home and commercial appliances.

Fourth, high-tech industries are expected to have an impact comparable to the industrial revolution. For example, innovations in the field of electronics have led to a number of dramatic changes, including office and factory automation, the advent of new media, and spectacular progress in telecommunications. Links with other fields are spawning a variety of new industries engaged in electromechanics, medical electronics, and optoelectronics. In addition to these obvious effects on the structure of industry, electronics innovations are also producing changes in employment systems, the quality of labor, life styles, value systems, and social institutions.

The industrial revolution led to changes in the structure of industry as old industries gave way to new ones. This in turn altered the hierarchy of comparative advantage among the advanced nations, and the resultant changes in the structure of foreign trade were the vehicle for shifts in international economic and political systems. If today's high-tech industries can indeed have an impact comparable to the industrial revolution, we should already be able to detect signs of change. Let us now consider recent trends in the structure of Japan's industry and the pattern of its foreign trade.

## Structural Changes in Industry and Foreign Trade

### 1. Expansion of High-Tech Industries

An analysis of shifts in production trends during the 1970s and 1980s shows that changes have been particularly marked during the 1980s (Table 1). The outbreak of the first oil crisis in the autumn of 1973 was accompanied by dramatic declines in the output of almost all industries. This downturn was particularly marked in the areas of ceramics and earthenware, textiles, and nonelectric machinery, with the result that 1975 production figures were lower than those in 1970.

A period of expansion then commenced, lasting until the second oil crisis of 1979-80. The pace of expansion was particularly rapid in the machinery industries, but at this stage the gaps between industries were not large.

The gaps tended to become more pronounced after the second oil crisis. Production stagnated in such materials industries as steel, nonferrous metals, textiles, chemicals, ceramics and earthenware, and paper and pulp. The slump was particularly marked in the traditional mainstay industries of steel and textiles, where output levels were still below their previous peaks even in 1984.

Production of electric machinery and precision instruments, however, expanded smoothly. Particularly in the electric machinery industry, output almost doubled over the five-year period between 1980 and 1984. Obviously the rapid gains made by this industry were attributable to advances in electronics.

Trends in capital investment in plant and equipment will be the most important factor influencing future changes in the structure of Japanese industry. Instead of examining the share of high-tech industries in overall capital investment, here let us look at the level of investment in high-tech facilities in broad industrial categories. In this way we can evaluate the ripple effects of high-tech industries on other sectors, or in other words, the degree to which each sector is introducing high-tech innovations. The source of the data is a questionnaire survey conducted in August 1984 by the Japan Development Bank.

According to the results of this survey (Table 2), high-tech capital outlays accounted for 22.4 percent of total plant and equipment spending planned by all industries for fiscal 1984 (April 1984 to March 1985). Although this percentage is still low, it represents a 31.3 percent growth rate in high-tech spending. Moreover, its contribution to the growth in overall capital investment during fiscal 1984 is a high 56.2 percent.

The highest level of high-tech investment occurred in the processing and assembly industries, with a share of 39.9 percent of total capital investment. This represents a growth rate of 50.6 percent and a 66.8 percent contribution to the growth in capital investment in these industries.

It is also interesting to note that apart from the steel industry, in which capital investment declined below the fiscal 1983 level, the materials

industries also recorded a high level of high-tech investment, with a growth rate of 34.7 percent, accounting for a 25.1 percent share of the total and a 34.0 percent contribution to investment growth. This trend reflects the efforts of these industries to expand into high-tech areas as a tactic to offset slackening growth rates for their mainstay products and increasing competition from overseas industries.

These trends are indicative of the major changes that have taken place in the structure of Japanese industry, particularly after 1980, as a result of the expansion of high-tech industries. Since changes in the structure of industry are also manifested as changes in the structure of foreign trade, at this point it will be interesting to consider how the patterns of foreign trade among the major advanced nations have altered.

2. Changes in the Structure of Foreign Trade

Let us first examine the trends in the exports of the world's three main exporting nations: Japan, the United States, and West Germany.

There was little significant divergence in the trade performance of these three countries between 1970, prior to the first oil crisis, and 1980, at the end of the second oil crisis (Table 3). The value of Japan's exports increased 6.72-fold during this period, giving Japan a slight edge compared with the United States (5.11-fold) and West Germany (5.63-fold).

After 1980, however, the divergence became marked. Japan registered a decline in its exports in 1982 as a result of the simultaneous global recession, but it was back on a growth trend by the following year, recording a sharp gain of 15.8 percent in 1984.

The United States recorded declines in both 1982 and 1983, then returned to a growth trend in 1984 with a gain of 8.6 percent. West Germany's export statistics have continued to stagnate since 1980, showing little significant growth. (In Deutsche mark-denominated terms, however, there were gains of 1.1 percent in 1983 and 12.9 percent in 1984.) As a result, Japan has reached the same level as West Germany in the total value of its exports and has substantially narrowed America's lead.

Next let us consider the changes in the pattern of foreign trade (Table 4). As a percentage of total Japanese exports, machinery and equipment exports rose substantially from 26.9 percent in 1970 to 43.6 percent in 1984. Transport machinery exports also expanded, moving from 17.2 percent to 26.8 percent over the same period. By contrast, steel, textiles, and chemicals all registered relative declines. These trends are indications of the major changes that have occurred in the structure of Japan's export trade since the first oil crisis.

Since 1980 a gap has emerged between the machinery and equipment industry and the transport machinery industry. Whereas machinery and equipment exports have risen from 37.1 percent of total exports in 1980 to 43.6 percent in 1984, an increase of 6.5 percent, the share of transport machinery exports has remained virtually static because of a structural recession in the shipbuilding industry and voluntary curbs on auto exports to the United

States. This means that the machinery and equipment industry has accounted for the lion's share of the growth in Japan's exports since 1980, contributing 64.6 percent to the total increase recorded during this period.

Although dramatic changes have thus occurred in the structure of Japan's export trade, there have been few significant shifts in the export structures of the United States and West Germany. Like Japan, both countries suffered declines in the relative size of their steel and textile export industries. Exports by the machinery and equipment industry in America have remained static at around 30 percent of total exports, while the export share of the same industry in West Germany fell from 34.6 percent of the total in 1970 to 30.5 percent in 1982.

A comparison of machinery and equipment exports in terms of value reveals that Japan advanced from roughly half the American and West German levels in 1970 to replace the United States in the top position in 1983. Moreover, Japan is continuing to record double-digit annual growth in its exports of these products, further widening its lead over the United States and West Germany.

From this we can conclude that Japan's success in maintaining export growth during the upheavals that followed the oil crises was the result of an early commitment to the massive growth potential of the machinery and equipment industry, a decision that enabled Japan to strengthen its comparative advantages in this sector. The United States and West Germany were comparatively slow to pursue a similar shift in the structure of their industry, and consequently they suffered a slowdown in the growth of their overall exports.

As we have already seen, today's high-tech industries are concentrated within the machinery and equipment categories, particularly the electric machinery industry. The foregoing trends also mean, accordingly, that Japan's comparative advantages in high-tech industries have been growing.

The total value of Japan's imports is still below the peak recorded in 1981. Although declines in the prices of oil and other primary resources represent the major direct cause of this trend, another fundamental cause is the change in the structure of Japanese industry. With the growth of high-tech industries, the industrial sector's ratio of resource and fuel inputs to total inputs has been on a declining trend. This has led to the emergence of an industrial structure that produces massive surpluses in the trade and current accounts, and it has also significantly boosted Japan's influence on the world economy.

## The Future of Japanese Industrial Society

Thus far we have examined the growth of high-tech industries in Japan and the changes they have worked on the structure of Japan's foreign trade. The evidence clearly points to a strengthening of Japan's comparative advantages in the high-tech field, leading to a dramatic expansion of its share of world markets.

In view of the enormous growth potential of high-tech industries, obviously the strengthening of Japan's comparative advantages in these industries should be a key priority of growth strategy in the post-oil-crisis world economy. But if implemented without regard for Japan's trading partners or the harmony of the world economy, this strategy may lead to expanding trade imbalances. In particular, it may escalate clashes of interest with the United States.

Another key priority for Japan, therefore, is the creation of a system geared toward the harmonious development of both the Japanese economy and the world economy, particularly as represented by the U.S. economy. The most effective means of attaining this goal is to push Japan further along the road to internationalization.

Internationalization can be divided into its external aspects, such as capital exports and technology transfers, and its internal aspects, such as liberalization of Japan's domestic market.

There have been some changes in emphasis in terms of the external aspects. In fiscal 1983, for example, the electric machinery industry became the largest contributor to direct overseas investment by the domestic manufacturing sector, in the process ousting the previous leader, the auto industry. The electric machinery industry's overseas investments in the United States have been exceptionally brisk, multiplying about 2.5 times between fiscal 1982 and fiscal 1983.

Such sharp changes contrast with the developments relating to internal aspects in the form of liberalization of Japan's market. Here there is an urgent need to achieve more results. The United States in particular is pressing for freer access to market sectors in which its own industries enjoy a comparative advantage and future growth prospects, notably telecommunications, data processing, medical equipment, pharmaceuticals, finance, and services. Japan will need to exercise enlightened judgment and base its response on the long-range perspective.

Japanese industrial society is on the threshold of a new era of development in which the main priorities will be internationalization and the shift to a high-tech industrial structure. These changes are expected to make the Japanese economy an increasingly significant force in the world economy. The role that Japan will need to play in the development of the world economy will grow correspondingly.

* * * * * *

Table 1: Indexes of Industrial Production

(1980 = 100)

| Year | Total | Steel | Nonferrous Metals | Nonmetallic Mineral Products | Chemicals | Paper and Pulp | Textiles | Nonelectric Machinery | Electric Machinery | Transport Equipment | Precision Instruments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1970 | 66.9 | 75.3 | 66.7 | 76.3 | 60.9 | 73.1 | 97.1 | 66.6 | 42.9 | 56.3 | 29.4 |
| 1971 | 68.6 | 73.0 | 68.1 | 77.4 | 64.3 | 74.9 | 100.9 | 64.3 | 43.7 | 62.4 | 29.5 |
| 1972 | 73.6 | 78.9 | 77.1 | 82.7 | 68.2 | 79.5 | 102.2 | 64.8 | 49.6 | 69.1 | 31.5 |
| 1973 | 84.6 | 94.9 | 91.4 | 95.5 | 77.3 | 88.9 | 109.3 | 81.8 | 60.1 | 79.5 | 35.9 |
| 1974 | 81.2 | 93.4 | 80.1 | 88.4 | 77.1 | 84.7 | 97.8 | 80.0 | 58.1 | 80.4 | 39.6 |
| 1975 | 72.3 | 79.9 | 71.1 | 75.5 | 70.1 | 74.5 | 92.2 | 63.4 | 49.2 | 76.9 | 36.6 |
| 1976 | 80.4 | 87.6 | 84.8 | 83.3 | 78.2 | 84.4 | 100.0 | 69.6 | 63.1 | 78.6 | 46.9 |
| 1977 | 83.7 | 86.4 | 88.9 | 87.0 | 82.2 | 85.9 | 98.4 | 74.0 | 67.2 | 81.7 | 60.7 |
| 1978 | 89.0 | 88.8 | 95.5 | 92.0 | 92.3 | 91.8 | 99.8 | 81.3 | 76.3 | 80.4 | 68.7 |
| 1979 | 95.5 | 98.4 | 100.1 | 97.7 | 100.5 | 99.5 | 101.4 | 91.7 | 86.8 | 83.7 | 80.4 |
| 1980 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1981 | 101.0 | 93.6 | 95.8 | 94.1 | 99.8 | 94.4 | 98.4 | 102.2 | 113.9 | 105.8 | 109.4 |
| 1982 | 101.3 | 91.4 | 92.6 | 91.5 | 102.5 | 97.1 | 97.4 | 100.6 | 125.2 | 99.1 | 103.5 |
| 1983 | 104.9 | 89.1 | 95.5 | 92.7 | 108.8 | 102.7 | 96.8 | 99.8 | 149.6 | 94.6 | 110.3 |
| 1984 | 116.5 | 98.3 | 100.4 | 95.9 | 118.0 | 108.0 | 99.0 | 113.0 | 193.6 | 104.2 | 127.8 |

Source: Ministry of International Trade and Industry, Industrial Statistics Monthly

Table 2: Trends in High-Tech Capital Outlays in 1984

(construction basis)

| | Growth Rate of Overall Capital Investment | Growth Rate of High-Tech Capital Outlays | Share of High-Tech Capital Outlays in Total | Contribution of High-Tech Capital Outlays to Growth of Overall Capital Investment |
|---|---|---|---|---|
| All Industries | 10.5% | 31.3% | 22.4% | 56.2% |
| Materials Industries* | 8.2 | 35.5 | 18.2 | 63.2 |
| Materials Industries (excluding steel) | 23.5 | 34.7 | 25.1 | 34.0 |
| Processing and Assembly Industries** | 25.1 | 50.6 | 39.9 | 66.8 |
| Nonmanufacturing Industries | 10.9 | 13.5 | 16.5 | 37.3 |

Notes: *Textiles, paper and pulp, chemicals, nonmetallic mineral products, steel and nonferrous metals.
**Food, nonelectric machinery, electric machinery, transport equipment and precision instruments.

Source: Questionnaire survey by the Japan Development Bank (surveyed in August 1984)

Table 3: Export Trends for Japan, United States and West Germany

(in millions of dollars)

| | 1970 | 1975 | 1980 | 1981 | 1982 | 1983 | 1984 |
|---|---|---|---|---|---|---|---|
| Japan | $19,318 | $55,754 (6.72%) | $129,807 | $152,030 (17.1%) | $138,831 (-8.7%) | $146,927 (5.8%) | $170,126 (15.8%) |
| United States | 43,224 | 108,050 (5.11%) | 220,786 | 233,739 (5.9%) | 212,275 (-9.2%) | 200,538 (-5.5%) | 217,865 (8.6%) |
| West Germany | 34,228 | 90,176 (5.63%) | 192,861 | 176,090 (-8.7%) | 176,435 (0.2%) | 169,440 (-4.0%) | 171,546 (1.2%) |

Note: Figures in parentheses show year-to-year growth.

Sources: 1970-80 - Bank of Japan, Statistics of International Comparison; 1984 - preliminary data released by each country.

Table 4: Changes in Export Structure of Japan, United States and West Germany

(in millions of dollars)

| | Food | Materials and Mineral Fuels | Chemicals | Steel | Textiles | Machinery* | Transport Equipment | Other Manufactures | Total |
|---|---|---|---|---|---|---|---|---|---|
| **Japan** | | | | | | | | | |
| 1970 | $648 | $401 | $1,234 | $2,844 | $1,744 | $5,191 | $3,318 | $3,784 | $19,318 |
| | (3.4%) | (2.1%) | (6.4%) | (14.7%) | (9.0%) | (26.9%) | (17.2%) | (19.6%) | (100.0%) |
| 1975 | 760 | 1,094 | 3,885 | 10,165 | 2,903 | 15,277 | 14,138 | 6,780 | 55,754 |
| | (1.4%) | (2.0%) | (7.0%) | (18.2%) | (5.2%) | (27.4%) | (25.4%) | (12.2%) | (100.0%) |
| 1980 | 1,589 | 2,103 | 6,619 | 15,454 | 5,123 | 48,199 | 34,150 | 14,956 | 129,807 |
| | (1.2%) | (1.6%) | (5.1%) | (11.9%) | (3.9%) | (37.1%) | (26.3%) | (11.5%) | (100.0%) |
| 1982 | 1,404 | 1,766 | 6,238 | 15,645 | 5,104 | 53,789 | 37,762 | 15,587 | 138,831 |
| | (1.0%) | (1.3%) | (4.5%) | (11.3%) | (3.7%) | (38.7%) | (27.2%) | (11.2%) | (100.0%) |
| 1983 | 1,399 | 1,100 | 6,982 | 12,843 | 6,613 | 60,417 | 39,143 | 11,364 | 146,927 |
| | (0.9%) | (0.7%) | (4.8%) | (8.7%) | (4.5%) | (41.1%) | (26.6%) | (7.7%) | (100.0%) |
| 1984 | 1,440 | 1,249 | 7,550 | 19,168 | 6,755 | 74,253 | 45,556 | 12,474 | 170,126 |
| | (0.8%) | (0.7%) | (4.4%) | (11.3%) | (4.0%) | (43.6%) | (26.8%) | (7.3%) | (100.0%) |
| **United States** | | | | | | | | | |
| 1970 | 5,058 | 6,693 | 3,826 | 1,270 | 600 | 12,681 | 6,357 | 4,636 | 43,224 |
| | (11.7%) | (15.5%) | (8.9%) | (2.9%) | (1.4%) | (29.3%) | (14.7%) | (10.7%) | (100.0%) |
| 1975 | 16,797 | 15,193 | 8,705 | 2,457 | 1,625 | 31,716 | 16,533 | 9,988 | 108,050 |
| | (15.6%) | (14.1%) | (8.1%) | (2.3%) | (1.5%) | (29.4%) | (15.3%) | (9.2%) | (100.0%) |
| 1980 | 30,318 | 33,705 | 22,430 | 3,116 | 3,632 | 62,520 | 25,131 | 24,264 | 220,786 |
| | (13.7%) | (15.3%) | (10.2%) | (1.4%) | (1.6%) | (28.3%) | (12.7%) | (11.0%) | (100.0%) |
| 1982 | 26,856 | 33,542 | 19,906 | 2,166 | 2,784 | 68,406 | 27,060 | 19,555 | 212,275 |
| | (12.7%) | (15.8%) | (9.4%) | (1.0%) | (1.3%) | (32.2%) | (12.7%) | (9.2%) | (100.0%) |
| 1983 | 26,979 | 29,555 | 19,751 | 1,415 | 2,368 | 60,165 | 28,269 | 20,459 | 200,538 |
| | (13.5%) | (14.7%) | (9.8%) | (0.7%) | (1.2%) | (30.0%) | (14.1%) | (10.2%) | (100.0%) |
| **West Germany** | | | | | | | | | |
| 1970 | 1,066 | 1,944 | 4,093 | 2,530 | 1,494 | 11,832 | 5,110 | 5,596 | 34,228 |
| | (3.1%) | (5.7%) | (12.0%) | (7.4%) | (4.4%) | (34.6%) | (14.9%) | (15.3%) | (100.0%) |
| 1975 | 3,671 | 5,222 | 10,477 | 7,971 | 3,256 | 31,242 | 12,979 | 13,724 | 97,176 |
| | (4.1%) | (5.8%) | (11.6%) | (8.8%) | (3.6%) | (34.6%) | (14.4%) | (15.2%) | (100.0%) |
| 1980 | 9,261 | 12,080 | 24,318 | 11,551 | 6,352 | 60,707 | 30,714 | 33,281 | 192,861 |
| | (4.8%) | (6.3%) | (12.6%) | (6.0%) | (3.3%) | (31.5%) | (15.9%) | (17.3%) | (100.0%) |
| 1982 | 9,070 | 10,448 | 21,185 | 9,819 | 5,572 | 53,780 | 34,020 | 28,334 | 176,435 |
| | (5.1%) | (5.9%) | (12.0%) | (5.6%) | (3.2%) | (30.5%) | (19.3%) | (16.0%) | (100.0%) |

*Nonelectric machinery, electric machinery and precision instruments.

Sources: 1970-82 - calculated from Bank of Japan, Statistics of International Comparison; 1983 - Ministry of International Trade and Industry, White Paper on Commerce; and 1984 - preliminary report by Ministry of Finance.

# NOTE

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